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THE PRODUCTION OF THE EASTER LILY IN NORTHERN CLIMATES.

By DAVID GRIFFITHS, *Horticulturist, Office of Horticultural and Pomological Investigations.*

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THE CHOICE OF METHOD OF PROPAGATION.

IT IS ASSUMED that the grower of Easter lily stocks will start with seedlings. He may sow seed each season, but it is more likely that he will grow seedlings the first year and propagate vegetatively thereafter. When vegetative propagation is chosen the plants must be hardy enough to go through the winters safely out of doors. It has been amply demonstrated that the lily is sufficiently hardy in the latitude of Washington, D. C., to live through the winter either with or without a little mulch. The probability is that it will be found to be hardy very much farther north. If the grower goes back to seed each year it makes no difference whether the species is hardy in his locality or not, for the plants will not be in the open ground during the winter.

The stock plants may be of any standard commercial variety, or any two standard varieties may be crossed. Good results have been obtained by cross-pollinating the varieties Giganteum and Har-

risii, Giganteum and Formosum,[1] or even two plants of any one of the above varieties.

A grower will succeed more often by pollinating one plant on to the other than by using only one parent plant, or, in other words, selfing or pollinating a plant with its own pollen. It should be understood, however, that the basis of the stocks now grown by the Bureau of Plant Industry is selfed plants. But there was a deliberate purpose in view in starting in this way. The set of seed was uniformly small in nearly all of these selfs.

Pollination should be performed as soon as the stigma is receptive and the pollen ripe. This stage can be determined by watching the anthers as the flowers open. When the flower starts to open, the anthers will usually be found with simply a slight crack along one side, exposing a narrow line of dusty yellow pollen. After a time, which will vary with the light, temperature, and moisture conditions, the sides of this rupture will roll back, exposing the mass of dusty pollen over the entire surface of the anther. As soon as this condition is evident the pollen should be transferred to the stigma which is to be fertilized. The time which it will take from the gaping of the flower until the stigma is receptive, i. e., ready to be pollinated, will vary with atmospheric conditions. Under autumnal conditions in the greenhouse in cloudy weather it has taken 27 or 28 hours after the tube began to open before the stigma was receptive, while in the open in July flowers starting to open about sunrise were ready to be fertilized at 9 or 10 o'clock. The grower will have to determine this period quite definitely. In general, it can be said that the stigma is ready to receive pollen as soon as its surface becomes glossy on account of the secretion of a viscid fluid, which in this lily is about the time when the edges of the anthers have rolled back and completely exposed the yellow dusty pollen content. The sooner the pollination is done after these conditions obtain the better.

The Easter lily may be grown under wide extremes of conditions, but it is difficult under conditions which might be termed intermediate. It seems to be a safe crop when properly handled in the climate of either Washington, D. C., or the frostless Bermudas, but in the Gulf States it succumbs to the occasional low winter temperatures. This is not by any means without a parallel, the most striking one, possibly, being the hardiness of the Concord grape on the Great Lakes and its tenderness to frost conditions in Florida, and is readily explainable by the fact that farther north the plants are dormant during cold weather, while in the intermediate region they

[1] The botanical name of the Easter lily is *Lilium longiflorum*. The above names designate varieties which in commercial literature are usually referred to as here used without reference to their technical specific designation, *L. longiflorum*.

may be subjected to severe freezing weather when in full vegetative vigor.

There is evidence at hand that with care this lily may be grown much farther north in selected localities than has thus far been advised. There is little doubt that in those northern regions where the snowfall is heavy and early, even though the temperatures be very low, it can be safely grown in the open ground.

PRODUCTION ON A SEEDLING BASIS.

GROWING THE SEED.

Until such a time as the trade produces seed of the Easter lily and offers it for sale, it will be necessary for the grower to raise his own seed. The most feasible way to do this now is to procure imported bulbs either in the early winter, when they are generally offered for sale, or at Easter time, when most of the plants are in blossom, and grow seed for planting the following January.

To insure a good set of seed it is necessary to hand-pollinate each flower. (Fig. 1.) The blossoms are so large and their parts so conspicuous, that this is a simple and easy task. Seed may be produced in limited quantity without this trouble, but in the greenhouse, especially, the fertilization will be largely accidental and the set very poor or none at all.

If it is the florist's object to cross particular varieties, care should be exercised that no pollen except that which is wanted gets on the stigma. It will be necessary to remove the anthers from the flower to be fertilized before they open and spread their pollen. If the plant which has been pollinated is set 2 feet or so away from others which bear pollen, it is ordinarily safe from contamination in the greenhouse. Usually the florist is not interested in following up a line of breeding, and all that he needs to do is to see that plenty of pollen is put on the stigma at the proper time.

If pollinations are made at Easter, the seed will be ripe early in June. (Fig. 2.)

NECESSITY FOR HAND POLLINATION.

In the flower of the Easter lily the stigma is quite well isolated from the anthers. The action of the wind or other agency may cause the pollination of a flower with its own pollen, which, of course, is the closest kind of selfing. Also, it is possible, when plants are grown in the open, that cross-pollination at times may take place through the influence of insects and birds, but of this there seems to be little evidence. The necessity of hand pollination to obtain full fertilization consequently becomes apparent. Some seed will be obtained without any attention other than allowing the flowers to wither nat-

urally in the field, but a much better set can always be obtained by thorough artificial pollination.

SELFED COMPARED WITH CROSSED PROGENIES.

In the recent investigations made by the Bureau of Plant Industry no attempt was made to obtain excessive vigor in the stocks handled.

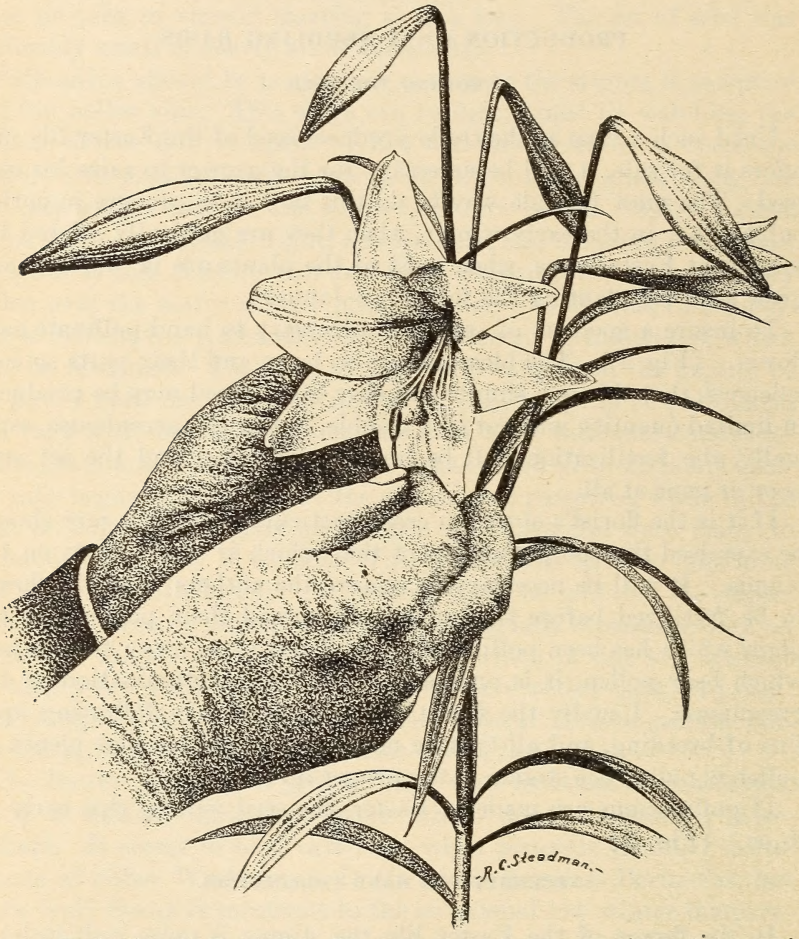

FIG. 1.—Pollinating the Easter lily. The parts of the flower are so large that even the conventional tweezers are dispensed with.

Some years ago Mr. George W. Oliver, working on this subject under departmental auspices, developed some remarkably vigorous progenies by crossing the two commercial strains, Harrisii and Giganteum.[1] Other investigators have obtained similar results by crossing

[1] Oliver, George W. The production of Easter lily bulbs in the United States. U. S. Dept. Agr., Bur. Plant Indus. Bul. 120, 24 pp., 4 pls. 1908.

the varieties Multiflorum and Harrisii. The progenies with which work has been done recently have as their basis selfed plants, i. e., those produced from the pollen of a plant used on its own stigma instead of on the stigma of another plant of the same or a different variety. Subsequently, cross-pollinations of plants in the same lots have been practiced for the most part.

Commonly, but not always, the set of seed in selfed plants is small as compared with that obtained when two plants of the same variety or of different varieties have been crossed.

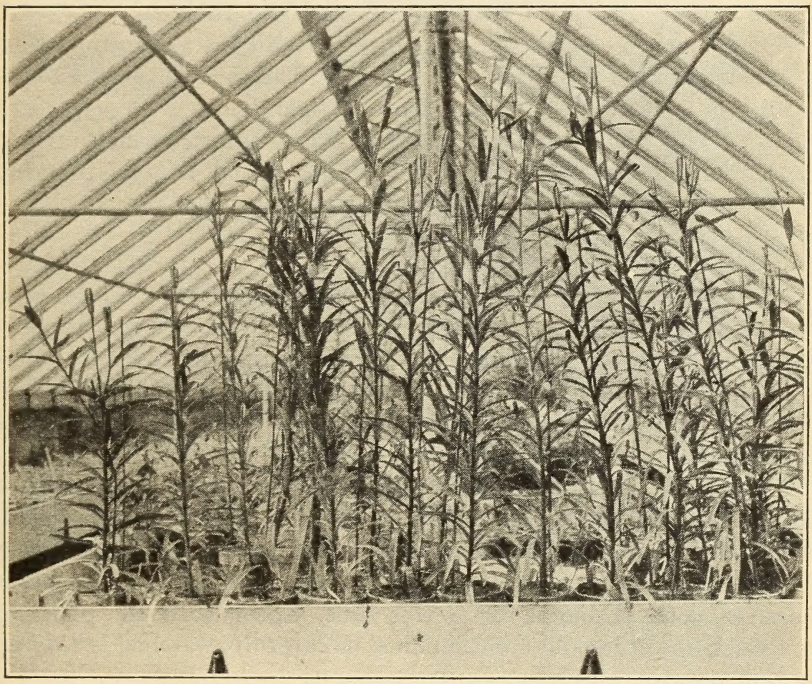

FIG. 2.—A crop of Easter lily seed being produced in a greenhouse.

LONGEVITY OF THE SEED.

There is but little information as to the length of time that the seed of the Easter lily will remain viable after it is harvested. Experience has shown that if planted as soon as it is gathered it takes about twice as long to germinate as when held and planted 6 months later. Perfect germination has occurred when the seed was 18 months old. This shows that perfect results may be expected from seed held over to the second year. Whether seed can be safely held longer is not known. All the seed worked with in these investigations was stored in paper sacks in the packing shed of an ordinary greenhouse.

PLANTING THE SEED.

The time of planting seed will depend upon how the florist is going to handle his stocks, and possibly upon when his seed becomes available. Sowing can be done at any season if suitable moisture conditions for germination are maintained. If seed is planted out of doors, it should be sown in late autumn for spring germination.

For germination in flats, the usual compost of loam, sand, and leaf mold with a very little well-rotted manure is preferred. Good success has been obtained with a variety of potting soils, even with quite heavy clays ameliorated with a little sand and rubbish.

The best practice in sowing the seed is to fill the flat to the proper depth and strike the surface to a level. The seed is then scattered over this surface and pressed down rather firmly with a piece of board. The whole is then covered with one-eighth to one-fourth of an inch of fine soil sprinkled over the top. In out-of-door plantings it is better to put the seed three-fourths to 1 inch deep.

HANDLING THE SEED FLATS.

To the experienced plantsman the best direction that can be given on the subject of handling is "keep the flats in proper condition for germination." This condition does not differ for most seeds. Moisture should be kept at the surface constantly, but good provision for drainage should be made, so that the soil will never become waterlogged.

If it is not possible to keep the surface properly moist without it, a pane of glass can be laid over each flat, but if the moisture conditions of the greenhouse are as they should be this is not necessary. It will be all the better not to have had the glass on when the plants begin to come through, for at this time, especially if the plantings are thick, moisture and aeration must be carefully watched lest damping-off occur.

The flats after germination are preferably kept rather dry. Watering should be copious, with provision for rapid drainage, but at comparatively infrequent intervals, so that the seedlings and the surface of the soil be not too wet. Clay seed pans can be used, in which case it will not be necessary to wet the young foliage at all for a time.

The time it takes for the seed to come up will vary greatly with conditions. The first lot of seed produced in these experiments ripened in June. It required six or seven weeks to germinate when sown immediately after being gathered. The same seed planted the following January came up in three weeks.

POTTING.

The exact stage of growth at which Easter lily seedlings should be potted may vary considerably. Usually it has been the practice

to transfer them to 2-inch pots when the second leaf was fairly well developed, although this has been done frequently when the first leaf was well straightened out. (Fig. 3.) It does not make much difference which practice is followed. At whatever stage they are transferred the plants seem to stand still for about three weeks after potting, and until the roots get out to the sides of the pot the top growth is always next to nothing; but after this the development is very rapid.

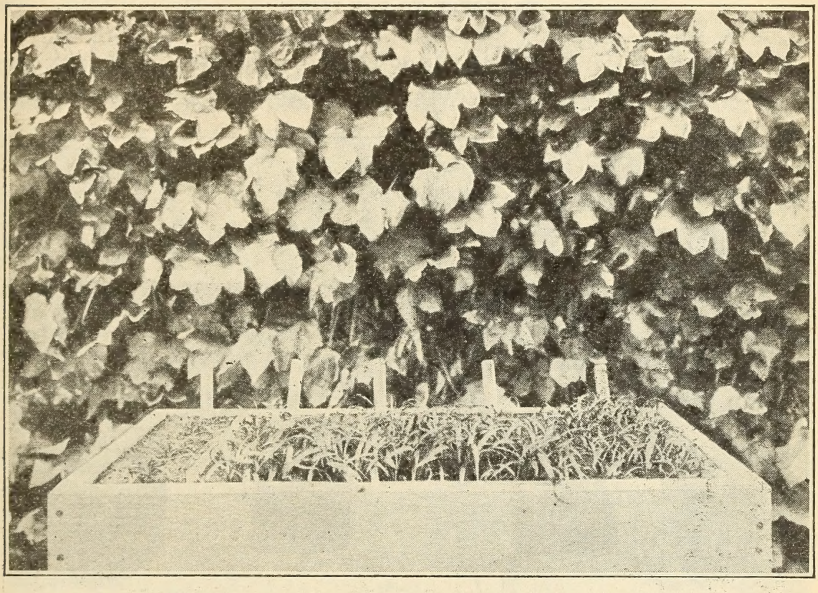

FIG. 3.—A flat of several lots of Easter lily seedlings ready to be potted.

TRANSPORTATION OF SEEDLINGS.

There is an opportunity for the development of a business in the production of 2-leaved or 3-leaved seedlings, to be furnished to florists or others to grow either in pots or in the open ground.

Such seedlings might be sold either directly from the seed flats or, after being established, from a first shift. The plants are as easily transported in the 1-leaved to 3-leaved stage as at any other time. They have been shipped from Washington, D. C., to California in mail packages several times, and have arrived in perfect condition. One trial package in fine condition when it reached California was rewrapped immediately and returned, but as it was not sufficiently protected from the cold it froze on the return trip.

A successful method of packing is to lay down, first, a strip of paper, then on this a ribbon of moist sphagnum moss 2 or 3 inches wide. The seedlings are placed on the moss with the tops all one way

and extending beyond the sphagnum ribbon. They may be spread three or four or more deep, also in a ribbon, on the packing material. When all the seedling plants have been arranged and covered with a similar layer of sphagnum, the whole may be rolled up tight, the paper being tightly folded about the bottom and loosely folded around the top. The package should then be tied and packed in a strong container, so that it can not move. (Fig. 4.) Thus handled, the seedlings can be transported cheaply to any part of the country.

TRANSFER TO THE FIELD.

If the seed of the Easter lily is sown about the 1st of January and potted in early March the plants will be ready to go into the open

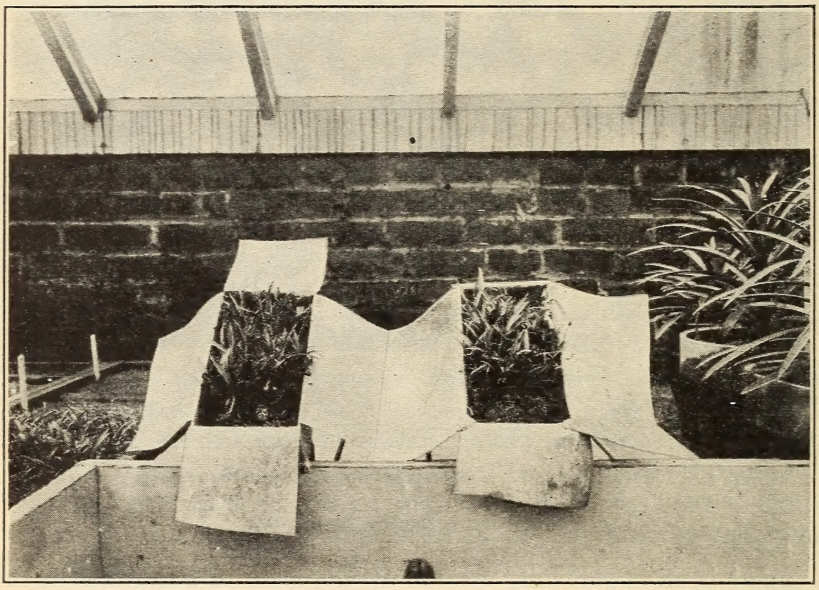

FIG. 4.—Easter lily seedlings in second leaf, showing the method of packing adopted for shipment by mail.

ground in late April or early May, or when they will be safe from any inclement weather. They are then knocked out of the pots and planted without disturbing the ball of earth. There seems to be no checking of growth, the plants taking hold of the ground with no loss of time.

When handled as stated, the 2-inch pots are well filled with roots by the time the plants go into the field. It is therefore possible to knock the plants out and carry them to the field in flats, from which they are set with a trowel.

CONDITIONS IN THE FIELD.

The experience of the Bureau of Plant Industry with these lilies has been restricted to a heavy retentive clay soil ameliorated by the use of some sand and plenty of very rough stable manure. None of these stocks have as yet been grown on sandy soil.

The seedlings have usually been set out in 3-foot beds 5 to 8 inches apart each way, which seems to afford ample space. Between the beds a 15-inch path has been left, which is also ample; a 12-inch path might be sufficient.

After planting, it is desirable to work a little mulch of some suitable material between the plants to assist in preventing the ground from baking, preserving moisture, and keeping the soil cool. For this purpose sand and spent manure from sweet-potato beds, old manure, and even fresh very strawy manure have been used. The care of these plantings during the summer has consisted in keeping down the weeds by hand and watering during dry weather. In well-prepared soil, mulched with some débris, hand weeding is not a serious matter.

DEVELOPMENT DURING THE SUMMER.

Lily plants set in the field from 2-inch pots in late April or early May will begin to throw up scattering stems in July, and some blossoms will appear late in the month. These early-flowering forms will be short, few flowered, and in general disappointing. As the season advances the stems become longer and bear a large number of flowers, but never are the plants in the field as tall as those in the greenhouse, although they often reach a height of 24 inches or more. When the time for frosts arrives there will be plenty of plants showing either flowers or buds to the number of three to seven, and in rare instances as many as a dozen. Possibly 25 per cent will have flowered, and the earliest will be maturing their seed, but most of the plants, nearly 75 per cent of them, will be in the form of large rosettes of basal leaves and plants which have started to form stems.

REPOTTING FROM THE FIELD.

Before there is danger of severe frosts in autumn the lily seedlings should be repotted for winter flowering. The minimum temperature to which they should be subjected out of doors is about 28° F.

The plants can be dug conveniently with a spading fork, ordinary care being used not to bruise them. (Fig. 5.) Most of the dirt is taken off the roots, and they are laid loosely in boxes, to be transferred to the packing shed. Here within three or four days they are put into the smallest-sized pots into which they will go. Most of them, though, will have to go into 6-inch pots, for the reason that on

account of the very large root system they can not be put low enough in pots of smaller size. There will be a goodly percentage of them, however, which can go into 4-inch and 5-inch pots. Whenever this is possible they should go into these small pots and be shifted to 6-inch pots when the smaller sizes are filled with roots.

LOSS OF LEAFAGE IN REPOTTING FROM THE FIELD.

It frequently happens that a goodly percentage of the bulbs, especially those which consist of the smallest number of basal leaves, lose all their leafage before they are placed in pots. No

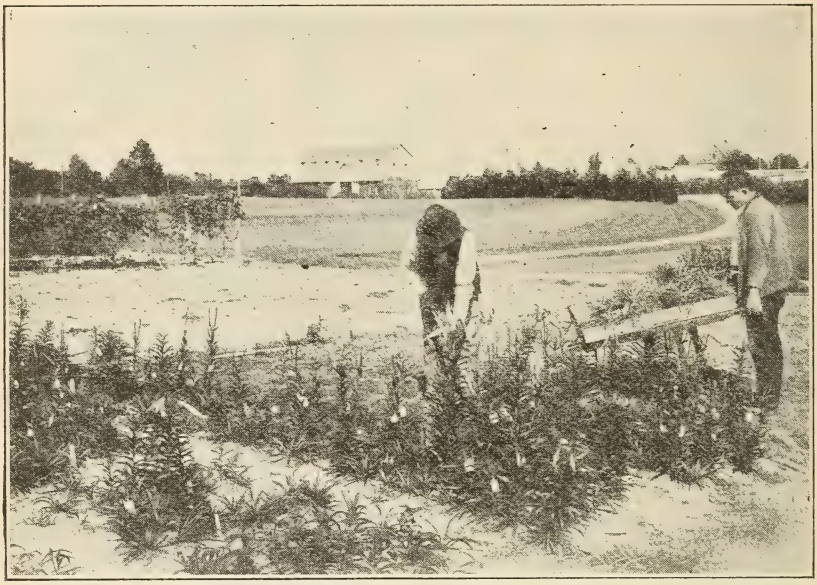

FIG. 5.—Digging Easter lily seedlings in October, 1920. The seed was sown on November 1, 1919. The plants are to be potted for winter flowering. Those which have not already flowered will be potted with the tops on and will not wilt.

change in handling is necessitated by this loss, these bulbs being potted and treated precisely like the others.

A most remarkable thing is the subsequent loss of leafage by the plants as they grow in the greenhouse. Those plants which are in the form of rosettes when repotted will in a few weeks be seen to lose their lower leaves gradually, so that by Christmas there will be but little of the field leafage left. Of course, the leaves in this case are from bulb scales. The loss never simulates wilting or any other apparently unhealthy condition, but looks simply like a gradual ripening process.

This loss of leafage is by no means confined to the scale leaves. The same loss takes place in the stem leaves of those plants which were

in a more or less advanced stage of stem development when repotted. The lower leaves gradually ripen and dry up in the same way, often leaving naked a few inches of the stem at the surface of the pot. This leaf loss takes place even when the plants have not been subjected to frost in the field.

TRANSPORTATION OF NONDORMANT BULBS.

The loss of the leaves naturally leads to the question whether it will be possible to produce seedling stocks, such as described, and transport them in autumn a reasonable distance to be repotted and forced. Experience this year seems to indicate that this can be done. Bulbs which had lost all their leaves were repotted and came right along in good shape, although in some cases they were not potted for four days after digging. It would not be surprising if it should be found feasible to wrap the plants singly in paper in a butcher's package, even in the advanced rosette stage, and pack them tightly in boxes for shipment, but this has not yet been attempted.

It should be noted that this is very different from the transportation of dormant bulbs, although it may not at first seem very different, especially when the seedling bulbs have lost their leaves. The bulbs referred to here, however, are in what might be called a vegetative condition, in distinction from the imported bulb, which is dormant. The imported bulb has a well-developed crown ready to go on and function the next season. The seedlings set out in May and dug from the field in a vegetative condition in October have a crown also, but it is in process of growth and its growth will build up another crown for the next season's development about the time that the plant blossoms. The fact that the bulbs can lose all their leaves at potting time and still go on and function satisfactorily from the same crown seems to warrant the conclusion that they can be transported safely for moderate distances.

CARE AFTER REPOTTING.

The plants are repotted from the field in all stages of development, from a rosette of basal leaves only to plants in full bud. (Fig. 6.) All can be potted in the same way and handled alike afterwards. It has been the practice to keep the pots on the benches in the greenhouse without heat from the time of repotting in October as long as the night temperature does not go below 40° F. As soon as there is necessity for heat a temperature of 45° to 50° F. is maintained at night until early December and then increased to a maximum of 60° F. The plants continue to flower during this period and from this time forward.

HANDLING PLANTS THAT HAVE FLOWERED IN THE FIELD.

At digging time the early seedlings (fig. 7) which have already blossomed in the field should be separated from the others and the stems cut off, but they can be potted like those which have not flowered and made to flower again by Easter, thus giving one small and one normal crop of flowers in 18 months from seed. They require no different treatment from those which have not flowered. However, if the florist desires, he can plunge them outside or treat them in all respects like imported bulbs.

FIG. 6.—A group of seedlings of the Easter lily of the 1919 progeny, selected from the field in late autumn to show diversity in development. Photographed a few days after they were potted from the field. All are of the same age.

GROUPING SEEDLING STOCKS.

As the bulbs are potted from the field it is possible to segregate them into five or more groups. One group will be in full bud and will blossom within 10 days or two weeks. Another can be made to blossom for Thanksgiving, another for Christmas, another in February, and the last for Easter. The last group will include the most backward of the plants in the field which have not flowered, together with the early-flowering forms which are to blossom the second time. Of course, by holding them at different temperatures, all except those in bud, and possibly even those, can be made to blossom at the later date.

NATURE AND APPEARANCE OF THE SEEDLINGS REPOTTED FROM THE FIELD.

As will be noted from the statements made on previous pages, the seedlings at potting time are exceedingly variable, the greatest variation occurring in the time at which they flower first, but there are also great differences of form aside from mere stature. (See fig. 6.)

As has been stated, the early-flowering plants are short, 12 or 15 inches high, but those in full bud at repotting time are 2 to $2\frac{1}{2}$ feet high and bear three to five flowers or more, while the first ones to open have one or two flowers as a rule.

FIG. 7.—Easter lily seedlings. Seed planted January 1, 1919; pricked off in March; set in the field May 1; blossomed in late July; photographed October 6, 1919. Two of the bulbs are double nosed; all are $6\frac{3}{4}$ to 8 inches in circumference.

Below those showing buds there are plants in all stages of growth. Some have a few inches to a foot of stem with no buds showing, while others present a varying degree of basal leaf development with no signs of stem growth. It is in this late group, which has the most prolific development of basal leaves, that the grower will find the most robust plants and also the most floriferous ones. It is not at all uncommon for these, when the flower stem appears, to show very large ones bearing 8 to 15 flowers.

Of all the field stocks thus handled, the preference is for the late-flowering forms, which bear a luxuriant growth of basal leaves, forming a large rosette at the surface of the ground at repotting time.

These are invariably vigorous and productive. Each of these basal leaves in seedlings tips a bulb scale, and it is found that the plants which hold back and build up a large store by the development of an abundant strong basal leafage before throwing up their flower stalks are the strongest and most productive.

The plants which have blossomed in the field are exceedingly interesting from the fact that they bear mostly double-nosed bulbs, which when potted will give at the second blossoming two stems bearing two to five flowers each. (See fig. 7.) Why this preponderance of double-nosed bulbs occurs at this stage so prominently in field-grown seedlings is not entirely clear. The condition is more general than in pot-grown plants, i. e., those kept in pots in the greenhouse through their first flowering. It looks sometimes as though the stem in the field is of such great diameter as actually to force a separation of one side of the bulb from the other, thus compelling the formation of two crowns for the next season instead of one, as normally obtains in bulbs of the same size developed vegetatively from small bulbs.

BEHAVIOR OF THE SEEDLINGS AFTER REPOTTING FROM THE FIELD.

The methods of handling the seedlings after they are repotted from the field have been considered under another heading. Their behavior is most satisfactory. In two years' experience in handling them in this way they have never even appreciably wilted, although three or four days have sometimes elapsed between the time of digging and the end of the potting.

In the handling incident to the transfer from the field to the pots some and frequently all of the leaves are broken off, for the basal leaves of seedlings, attached as they are to the tips of the scales, are quite brittle. There is, consequently, a goodly number of the bulbs which are entirely without leafage when ready to pot. No attention is paid to this, these bulbs being potted like the others. They invariably come on again in fine condition from the same crown; in other words, they are not to be distinguished from the dormant imported bulbs except that they grow more rapidly.

Strange as it may seem, these repotted seedlings, although moved with care and wilting but little, have to make in large measure a new root system after being potted from the field. Plants at all stages of growth, even up to full well-advanced buds which will open in 10 days, can be successfully repotted, but even these make an almost entirely new root system.

For this reason it will not do to subject the plants to heat until the pots have filled with roots again, any more than it is permissible to subject poorly rooted imported bulbs to such treatment. This point should be kept in mind. The grower should realize that he can

not subject these vegetatively potted plants to heat at the same stage of top development as dormantly potted bulbs. He should remember that these seedlings, which are all the way from large rosettes to plants in full bud and are perfectly "fit" in appearance, may have a great paucity of roots until new ones have had a chance to develop.

It is not intended to give the impression that all the roots on plants which come from the field rot off, but many, and probably most of them as a rule, and often all of them, do. In spite of this loss and the additional loss of leaves which may or may not accompany it, the plants seem to recover and continue to grow until they flower in a perfectly satisfactory manner.

What probably occurs is a rejuvenation or reestablishment of the uninjured roots and often of uninjured portions, all others decaying during the time that the plants are becoming established in the pots by the development of a new root system. There is need for careful investigation to determine to what extent the subsequent growth of plants would be injured by the complete removal of the root system when repotting them from the field while in vegetative condition.

In the care of this lily the imported bulbs always have their roots trimmed close, while an attempt is made with many lilies to save as much of the root system as is possible in handling.

It will probably be much better not to attempt to set a time limit on the period required for the lily plants to reroot at a temperature of 40° to 50° F. at night. It will be much safer for the grower to depend upon the condition of the root system, which is most accurately gauged by an examination of the plant knocked out of the pot. The same conditions should govern the application of heat here as with imported stocks, with which the grower is familiar.

TREATMENT OF SEEDLINGS NOT INTENDED FOR WINTER FLOWERING.

The previous discussion is based on the assumption that the lily seedlings are to be brought into the greenhouse for their first flowering, or in the case of the early ones for their second flowering, upon the advent of cold weather in late autumn. If the intention, on the other hand, is to carry them out of doors, it will be realized that the plants are at two decided disadvantages with reference to the approaching cold weather.

In the first place, all plants that have not flowered are going into the winter in full vegetative vigor and, in the second place, they are shallowly set on clean-tilled ground. Under such conditions in the climate of Washington, D. C., they may not winter successfully.

A very heavy mulch of coarse material, such as cornstalks, might protect the bulbs sufficiently, but it is believed to be much the better method of treatment to dig and reset them at the proper level before the ground freezes in the fall. The digging can be done either before

or after the tops are cut by freezing weather, but before there is danger of the ground freezing to any great extent. All the top growth should be cut off and the bulbs reset about 4 inches deep and mulched, preferably with an inch or two of manure, after the ground freezes a little. In the latitude of Washington, D. C., the digging and resetting can be done most advantageously about the 1st of November, when it is advised that dormant bulbs generally be planted. Handled in this way the seedlings will have a maximum period of development and will still have time to get a firm hold on the soil before winter sets in.

TREATMENT OF SEEDLINGS AFTER THEY HAVE FLOWERED IN THE GREENHOUSE.

The disposition made of the bulbs after flowering will depend entirely upon circumstances. If the florist sells potted plants, that, of course, is the end of the transaction. He will then produce more seed and raise a new crop of seedlings for each winter's flowering, as described in previous pages. If, as is more likely the case in all middle latitudes, he wishes to work up stocks of vegetatively propagated bulbs to be handled like imported stocks, it will be necessary to preserve the bulbs as his potted plants flower. In this case, the flowers can be cut with short stems for formal pieces, or even with a foot of stem cut. The pots should then be kept rather dry and allowed to dry up completely within a month or six weeks. Any time after the 1st of April, or before if the soil can be worked, the bulbs can be planted in the open ground.

The plants will blossom again in late July. In the fall they will be dug, the largest bulbs taken out for forcing or for sale, and the increase replanted in order to continue the outdoor growing.

PRODUCTION ON A VEGETATIVE BASIS.

PLANTING VEGETATIVELY PROPAGATED STOCKS.

The previous pages deal with seedling stocks up to the time they are ready to be propagated vegetatively, as the Easter lily is usually produced. If these same stocks are to be grown continuously the handling must, of course, be modified. Normally, the lily bulbs will be planted in late autumn; but if the first-year seedlings have been flowered in the greenhouse the bulbs will have to be planted out as soon as the ground can be worked in the spring.

The character of the field planting will probably resolve itself into a bed eventually, mainly on account of the advantage of a mulch, which becomes an excessive burden in any but the most intensive form of culture. No better method of planting can be recommended than the Dutch bed, in which the planted space is 3 feet wide, with a 12-inch to 15-inch path between the beds. The bulbs are planted seven to nine or more to the row across the bed. (Fig. 8.)

The bulbs should be separated into four or five sizes before planting. In spring plantings of the seedling bulbs out of the house, two sizes will probably be sufficient; for in this case the bulbs will be large, with very little, if any, propagation. They will be simply the large seedling bulbs. Assuming that the rows are uniformly 6 to 8 inches apart, the larger of these sizes can be planted about seven to the row and the smaller nine to the row. They should be uniformly spaced and set up. After the seedlings have been grown outside for a year, however, there will be a large propagation of bulblets, and consequently it will be better to make four or five sizes.

FIG. 8.—Bulbs being planted in a Dutch bed.

In starting the planting on the bed plan, it is necessary to line out the beds carefully with taut lines, marked off by running a spade down 2 or 3 inches along the line and scraping the soil toward the center of the bed from either side. The soil is then thrown out of the first bed to a depth of about 4 inches and the bottom raked to a level. The bulbs are then set and spaced, as already described. The soil from the opening of the second bed is used to cover the bulbs in the first, and so on to the end of the plat. Figure 8 shows this method of planting the narcissus on Puget Sound and illustrates the operation very well.

After the first year there will be more than two sizes, as there will be plenty of stem bulblets at the next digging. It will then be necessary to plant a larger number to the row. One may have 14 and 21

to the row set up, and another size strewn along the row about one to the inch. The latter should not be covered so deeply as the large bulbs.

A modification of the above method of planting which obviates the moving of so much soil has proved satisfactory. The ground is prepared as before and preferably floated or rolled. Rows are then opened up lengthwise of the bed with a wheel hoe having a plow attachment. A row is opened and planted, and then the second row is opened and the first covered by the same operation. Five or six of these rows 6 to 8 inches apart are planted; then a row is skipped for a path and the next bed started. Either of these forms of setting gives a thick planting, which it is believed is the most economical of space, labor, and materials.

TIME TO PLANT NORMAL VEGETATIVELY PROPAGATED STOCKS.

In vegetative propagation the time of planting will always be late autumn, though the date will vary with the locality. There are two important requirements that should be met. The bulbs should be well rooted before the ground gets so cold that no growth can take place. On the other hand, they should be planted so late that top growth will not take place before winter. The grower should endeavor to strike a balance between these two extremes, remembering that this lily does not stop growing so long as the moisture and temperature conditions are favorable. It is this characteristic that makes the crop a precarious one on portions of the Gulf coast, where suitable growing weather for it is likely to be interspersed with sudden drops of temperature which are severe enough to cut the top growth.

In the climate of Washington, D. C., the best time to plant is about the first of November. Even at this late date the plants sometimes come through in very open winters and are somewhat yellowed by subsequent cold weather in early spring, but no injury has been apparent thus far.

MULCHING.

The matter of a mulch is of sufficient importance to be treated separately; indeed, it has sometimes seemed that a mulch expressed the difference between success and a large measure of failure in growing these plants under field conditions.

The mulch serves a dual purpose. It is an adjunct to the fertilizer applied and a protective covering as well. The application should consist of an inch or two of manure. The material should be either fine or strawy and not cloddy, so as not to interfere with the plants coming through.

The application should be made in early winter after the ground has cooled off sufficiently so that growth is stopped, and it should remain during the growing season.

A summer mulch is considered as important in the culture of this lily as a winter one. Most lilies grow where there is a soil cover of some kind—many of them where this cover is a grassy one and others where the ground is just as effectively protected by brush, under and between which the lilies grow, sticking their heads above the canopy to flower.

Lilium longiflorum, with the forms of which we are dealing, produces a mass of roots from the stem above the bulb and near the surface of the ground. For the best results these roots, as well as those from the bulb, must have good conditions for development and must not be disturbed. This condition is admirably produced by a manure mulch, which not only furnishes plenty of fertility but prevents the soil from drying out and baking and also equalizes its temperature to a remarkable degree. One should keep in mind that this lily, like most other lilies, likes to have its feet moist and cool and protected both summer and winter, but its head must be in full light.

FLOWERING TIME FOR SEEDLINGS AND MATURE STOCKS.

Attention has been called in a general way to the irregular blossoming of a seedling generation. The experimental stocks in 1920, sown on November 1, 1919, began to flower in early July, at the same time as the out-of-door vegetatively propagated plants. The last of the progeny did not open its flowers before the end of May, 1921. All of these seedlings were kept under precisely the same conditions from the time of sowing the seed, and all operations, such as pricking off, potting, etc., were performed in as short a time as ordinarily would be possible. In spite of this identical handling, there was an extreme variation of 11 months in the time of flowering.

In all progenies which have been grown in the last six years the behavior has been similar. When, however, these same bulbs have been handled normally for vegetative stocks, i. e., planted in November, they have all flowered within a short space of time. (Fig. 9.) Two or three weeks cover the entire blossoming period, which is as close as would be the case with imported varieties grown out of doors in the same way.

THE CUT FLOWERS.

As in bulb culture, there is always a temptation to utilize the crop of flowers when there is sale for them. It has been found that it is practicable to cut off half of the stem in the first flowering of the seedlings in the greenhouse and still preserve the bulbs for starting vegetative propagation by planting out in the spring. The pots, after the cutting, are dried off rather quickly and the bulbs left in the soil until ready to plant out. There are no data on the comparative value of stocks thus flowered and those which have had their

tops cut off and planted at normal depths out of doors to flower the next year. The bulbs are without much doubt weakened by this cutting and quick drying off, but they blossom well again in late July in the field and appear to recuperate perfectly in one season.

In normal vegetative propagation the flowers in the field should be removed when in bud or shortly after they open. If there is a sale for them the individual flower stems 4 to 6 inches long may be safely taken off, in which case the blossoms can be utilized for formal pieces; but no leafage should be removed from the plants. If there is no object in letting the flowers open they can just as well, and more easily, be snapped off in late bud.

FIG. 9.—A block of about 1,500 mature bulbs of the Easter lily being seeded at the Arlington Experimental Farm, Va. In the foreground are seedlings of the current year. Photographed on July 7, 1920.

TIME TO HARVEST FALL-PLANTED STOCKS.

It must be frankly admitted that the best time to dig the bulbs of the Easter lily is not known. It is well known, however, that the period over which they may be dug and good results obtained is longer than with most bulbous plants.

With bulbous stocks generally the tops are allowed to die down before the plants are dug, but unless a severe drought occurs very few of these lilies will die before frost cuts them down in the fall. In a field planting nearly all the stems are in vegetative vigor when cold weather starts, though a few scattering stems may show signs of maturing.

Probably the best guide to the time of digging is the formation of the new crown for the next year's growth, but to the uninitiated this may be difficult to interpret properly. At times the abundant

formation of new roots, which appear in early September, has been the guide, and digging has been done when this occurs. This is probably to be looked upon as a reaction to more favorable temperatures for growth rather than an indication of maturity, but, nevertheless, stocks dug in early September, as the summer temperatures abate, have behaved perfectly under forcing and field conditions the next season. When dug at this season though, the bulbs must be looked upon as not fully mature and as comparable to much of the imported stock from Japan, which also is dug while in full vegetative vigor.

Digging has been done from September 10 to October 30. The performance of the bulbs dug during this period is about the same, so far as has been observed, but no careful comparative tests have been made.

When the bulbs are dug late there is commonly a small percentage of the stocks in which growth has started from the next season's crown. This growth is more likely to take place in the propagation than in the old bulbs. There is little doubt that there is in this characteristic a basis for selection, to which attention is now being given.

To sum up this matter, it can be said that the bulbs can be dug from September 10 to October 15 or 20 and that the late digging probably gives the best-matured bulbs, although those dug earlier apparently develop satisfactorily.

METHODS OF PROPAGATION.

Any plant to become widely useful must be able to make rapid increase. Lilies in general have been considered the aristocrats of the flower kingdom because of their beauty and the difficulties in producing them, but the Easter lily can be grown from seed so as to blossom in less than a year and can be produced vegetatively in one season. There are many methods of increasing the stock.

SEED.

Propagation by seed has been discussed in previous pages, and the method of handling has been fully described. Seed propagation gives clean stock and is a quick way of getting blossoming plants. It is also exceedingly desirable for various other reasons. It furnishes a quick and easy way to build up stocks from a few plants. It enables the small grower or the florist to produce his own forcing stocks and to get blossoms continuously from seven months after planting the seed up to and including the second Easter following the seeding. The method of propagation by seed is also very economical of time and effort, since the stocks may be carried out of doors for six months on a space practically equal to the size of the greenhouse required to

force them. Even in very cold regions where the plants will not stand the winter climate, florists can still produce their own flowering plants, for by this method of propagation the stocks are flowered in the greenhouse during the winter, having made their development out of doors during the summer.

FIG. 10.—Two stems of the Easter lily, showing the different character of reproduction. On the right seven bulblets 2⅛ to 3⅛ inches have been produced; on the left are 20 bulblets 2 to 2⅜ inches. The former is much the more desirable. Photographed late in October, 1920.

BULBLETS.

In the natural course of growing the plants, besides the bulb or bulblet planted, there is a propagation along the stem of from 1 to 30 bulblets which form in the axils of the leaf scales under the ground. (Fig. 10.) This is the most common method of propagation and is ample for continuing the stock and increasing it from year to year. These bulblets are taken off the stems at digging time and planted to continue the propagation. Commercial bulbs can be produced from the best of these in one year. They will not be so large as some commercial stocks now imported, but they will produce better.

SCALES.

The bulbs may be broken up into their individual scales, which can be planted in the open ground 2 inches deep or in flats in the green-

house. Bulblets form on the cut end of the scale, as in most lilies. The scales may also be incubated in a moist atmosphere in summer; the growth of the bulblets then becomes very much accelerated. They may be handled almost exactly like hyacinths in propagation, except that if they are not covered they require an atmosphere somewhat more moist.

FIG. 11.—Propagation of the Easter lily by cuttings inserted in sand in a greenhouse. The results shown were obtained in about three months. *A*, a 4-leaf cutting in which three bulblets have developed; *B*, a cutting from the terminal portion of a nonflowering stem; *C*, the best of the bulblets found on the cuttings; *D*, a cutting from the terminal portion of a stem, showing bulblets formed above ground as well as below.

CUTTINGS.

Cuttings of side shoots and various portions of stems with three or more leaf scales stuck in moist sand will live and form bulblets in a surprisingly short time. Such cuttings, so far as is known, do not root, but bulblets form in the axils of their leaves and these soon strike root. Figure 11 shows this well. Such growth as is shown in this illustration can be made in three months or less.

LAYERING.

Old stems which have blossomed may be layered in moist sand or simply laid on the surface of the ground in a moist atmosphere. When this is done bulblets form readily along the lower part of the stem.

BULB DIVISION.

A natural propagation takes place in the Easter lily, as in nearly all other lilies, by the division of the bulb into two or more after it reaches maturity. After such a division it is necessary to plant the units out one year to round up, or they can be forced as double-nosed bulbs.

BEST METHODS OF PROPAGATION.

The most useful methods of propagating the Easter lily are by seed and bulblet formation, the latter being the most common and in middle latitudes the most practicable for the production of dormant bulbs.

At present it seems advisable for growers intending to produce dormant bulbs for sale to start their propagation from seed, because of the freedom from disease and the greater vigor and general cleanliness of such stocks when compared with abused imported bulbs.

CONTROLLING BULBLET FORMATION.

A very large measure of control can be exercised by the grower over the amount of propagation. If the stocks are set shallow there will be less propagation by far than if the planting be deeper. In heavy, poorly aerated soils, however, there is a limit to the efficacy of deep planting, as the formation of bulblets is mostly confined to the upper 3 or 4 inches of soil. This fact is well brought out in figure 12, in which the bulblet formation will be seen to take place in the well-aerated soil near the surface of the ground.

It is also feasible to increase the propagation by the addition of more mulch or by banking up around the plants with earth.

SOIL FOR EASTER LILIES.

The Bureau of Plant Industry is not in a position to discuss the subject of soil for Easter lilies very exhaustively, for the reason that its stocks up to this time have been grown on only one type of soil. It can be said with confidence, however, that a clay loam is well adapted to the plants.

The soil on which these stocks of Easter lilies have been grown is basically a heavy, lean, bakey clay. This has been ameliorated with some sand, liberal dressings of rough manure, and cover crops. The response to this treatment has been all that

could be expected. As stated elsewhere, the winter mulch has been left on during the summer, in order to prevent the soil from baking. Success has also been obtained with these lilies in a plastic clay fill, ameliorated with hard-coal ashes and rough organic débris.

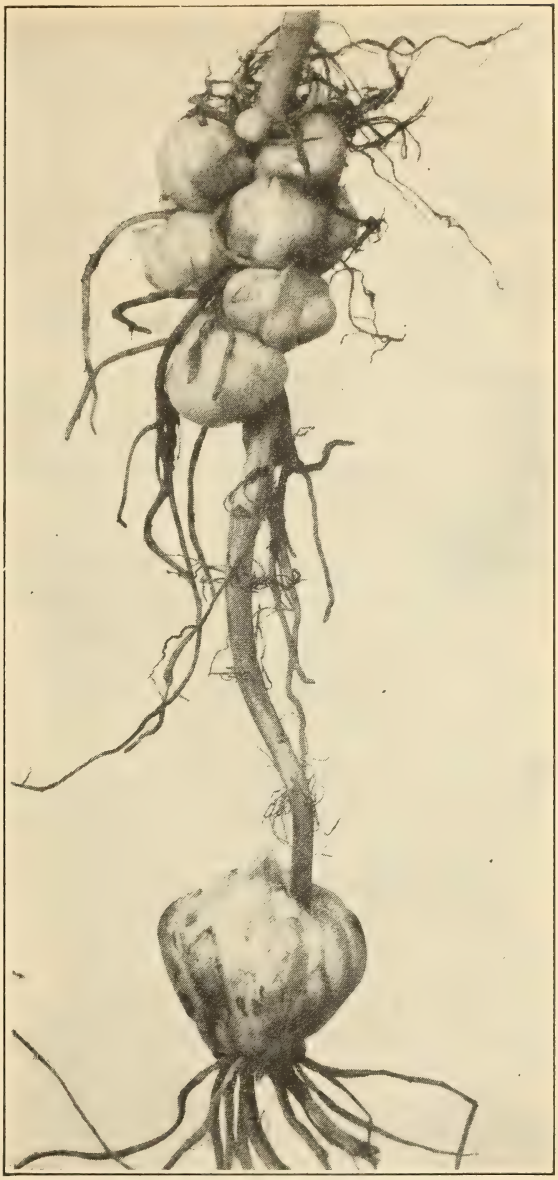

FIG. 12.—The underground parts of an Easter lily plant at digging time. The bulblet formation, it will be seen, is in the upper 3 or 4 inches of soil. Photographed from a plant set very deep, as was considered necessary in northern climates when these investigations were begun.

SOIL FERTILITY.

The production of bulbs of the Easter lily is on a par with bulb production generally in so far as fertilizer requirements are concerned. The procedure is to have well-fertilized soil and crop it to its limit. Any one familiar with the root system of a well-developed Easter lily bulb knows that there is not much left in ordinary soil after a bulb has been grown in each 6-inch square. The plants are gross feeders and for good results must be supplied with an abundance of available plant food. A good market gardener's application of fertilizer will answer very well.

The fertilizer used will be that which is most available. As indicated above, the experimental culture described in these pages has been on poor soil fertilized with stable manure, and the ground has been covered with crops to turn under whenever the time during which it was not occupied would permit. Manures should be well incorporated and applied sufficiently in advance of planting to avoid the detrimental effects of raw fertilizers. Experience indicates that rots in the base of the bulbs are rather easily induced by carelessness in the use of manures.

STORAGE OF BULBS.

Bulbs of the Easter lily should be exposed to atmospheric influences as short a time as possible. Imported stocks are packed in pulverized dry earth as soon as possible after they are dug. In this pack the evil effect of a bulb mass is avoided, the bulbs are kept dry, and excessive desiccation is prevented.

Cold-storage handling has been developed to a high degree of perfection. The bulbs are held 2 degrees above the freezing point for a year, and in some cases for two years, and still they give results. They usually go into storage in the original pack.

The handling of home-grown stocks is, of course, a matter for experiment. There is much to learn about it. The temperature must be kept down, the atmosphere kept dry, and the ventilation controlled, so as to prevent the bulbs from wilting too much. These requirements are not difficult to fulfill in September or October in a reasonably well-arranged building which is dry. The light on the bulbs should also be subdued or they will turn green in a short time. It is particularly important that the atmosphere of the storage house be dry, because root action starts very quickly in a moist atmosphere and blue mold is likely to cause trouble. If the bulbs must be kept out of the ground longer than a month, or six weeks at most, they are better packed in pulverized dry earth, as are imported stocks.

Stocks of bulbs of the Easter lily have been carried by the Department of Agriculture on a basis not altogether ideal. The bulbs were out of the ground in 1920 from September 20 to November 1 and were somewhat wilted when planted, but not injuriously so. After digging they were worked over on the benches in a greenhouse, a very bad place. They were then stored in a poorly ventilated half basement which was only moderately dry.

It is not a difficult matter to hold the bulbs over winter in the climate of Washington, D. C. They have been carried over for spring planting in almost perfect condition when packed like imported bulbs in dry sand in boxes and buried in dry earth under a porch of a dwelling. The box was put down in the ground 1 foot

and had an added covering of another foot of dry leaves. These bulbs kept in good condition up to the 1st of May.

SIZES OF MERCHANTABLE BULBS.

Imported stocks of Easter lily bulbs range in size from 6 to 12 inches in circumference, the price charged being roughly proportional to the size of the bulb and indicating in a general way that there is merit in large size which is of advantage to the florist. There is a difference of opinion on this point, and some of the best growers use the smaller sizes.

Commonly, the prices quoted are the same per case for all sizes. In a recent quotation by one of the leading importers, five sizes of Formosums, running from 6 to 11 inches, are advertised at the same price per case; but the number of bulbs in the case varies from 100 for the large size to 350 for the smaller. Here there is a difference of $3\frac{1}{2}$ to 1 when the number of bulbs is considered.

It is believed that the yield from the successful culture of imported bulbs is somewhere between three and five flowers per plant for all sizes. There are no comparative records of the performance of different-sized bulbs available, but practical growers express satisfaction with the yield mentioned.

Investigations by the Bureau of Plant Industry are not yet extensive enough to warrant more than partial conclusions with reference to these matters, but the few records which have been made are very suggestive and seem to indicate that the performance of domestic stocks is superior to that of the imported bulbs; at least, results which are superior to those just mentioned are secured. This may be due to the better condition of the bulbs, owing to the short time during which the domestic stocks are out of the ground. It is not believed that the manner of handling accounts for the better behavior. Whatever be the cause, it has been possible to obtain an average yield of more than five flowers from bulbs only 5 to 6 inches in circumference, the smallest size that the florist uses, or smaller.

This in reality is a very important matter. It means that if satisfactory results can be secured under forcing conditions from domestic bulbs 5 to 7 inches in circumference, they can be produced abundantly in one year from stem bulblets. This is not less than a year shorter time than is at present required to produce bulbs in foreign countries.

It should be noted that the best of the stem bulblets will blossom the first year of independent existence and grow to forcing size. (Fig. 13.) In one test an average of more than two flowers per bulb was secured under forcing conditions from 110 selected bulblets, some producing five and six flowers. (Fig. 14.)

VARIETAL SELECTIONS.

But little has been accomplished in the segregation of uniform strains of Easter lilies. The seedlings are especially variable in form, and it is thought that selections based on individual performance will yield the best results. In seedlings in the vegetative condition upward of 30 more or less distinct types are recognizable. They have not been studied long enough to determine their relative qualities. This will take time.

The season at which distinctions in vegetative characters are most noticeable is that just preceding the formation of flower buds, strange as it may seem, but there are many characters which are quite pro-

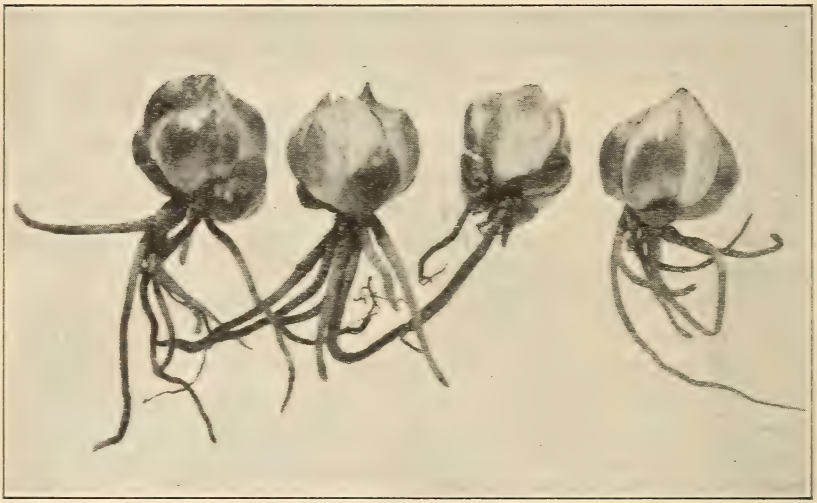

FIG. 13.—Four stem bulblets from a single stem, measuring 3½ to 4 inches in circumference. These bulblets will be large enough to force after growing one year. This kind of reproduction is much more desirable than a larger number of smaller bulblets.

nounced even in the rosette stage. Selections can profitably be made before the buds show, and a reselection after the flowers open. It will probably be worth while also to make selections based on bulb characteristics.

Whether the early-flowered seedlings perpetuate the characteristic of early flowering in the vegetative progeny is not known. Some plants start into new growth early, i. e., the new crowns for the next year begin to grow even before the first flowers have faded. Fortunately, the percentage of these is small, and they probably should be eliminated. The desirable bulb is one that forms a large, promising crown for next year's performance which remains dormant during autumn if not disturbed.

Another aspect of the subject is the desirability of producing uniformity in seedlings, a much more difficult matter than to produce it in the vegetatively propagated progenies selected from these seedlings. This also is being attempted.

THE EASTER LILY IN BEDS AND BORDERS.

No lily is more satisfactory for beds and borders than the Easter lily. It is also well adapted in our middle latitudes for permanent plantings. In spite of what has been said in previous pages about the necessity of making plantings so late that no top growth will take place, in a permanent planting there is a wonderful adaptation,

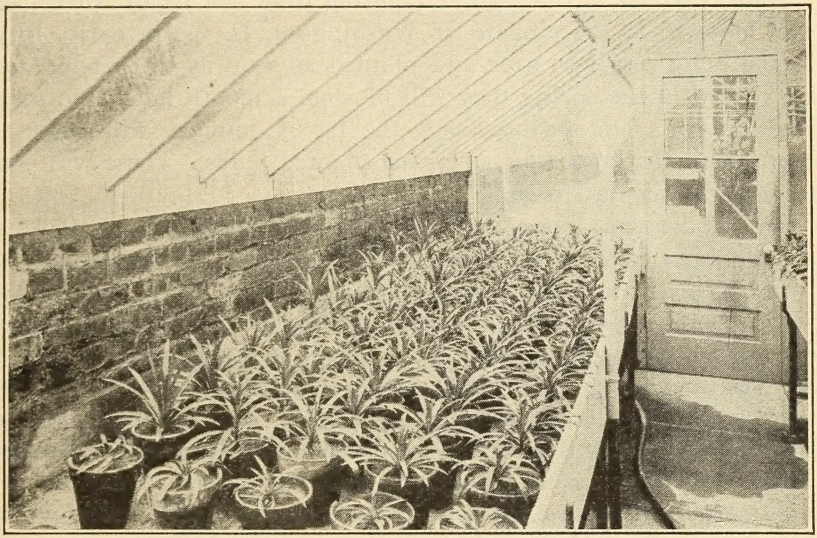

FIG. 14.—A selected lot of 110 stem bulblets forced in order to determine their flowering qualities. The smallest are in the foreground. Three did not flower. The average for the entire lot was 2½ flowers per plant, one producing six flowers.

and under ordinary conditions there is no more danger from forced early growth than with many other herbaceous perennials.

In permanent plantings the stems should be allowed to function until quite late in the autumn. If they do not die down naturally they can be allowed to grow until killed by frost. It is seldom cold enough for this, though, in the climate of Washington, D. C., before the regular time of planting, about November 1.

In permanent plantings it is advisable to allow the plants to set seed. Observations seem to show that the stem functions longer in autumn when a crop of seed is being produced than when the pods have been removed. The late functioning of the old stem retards activity in the next season's growth until the ground becomes too cold for top growth to take place.

Late in the season, say about November 1, it is desirable to go over the beds and loosen the soil around the stems, being careful not to interfere with the bulbs. After the soil is loosened a quick jerk will remove the stem and its bulblets, leaving the bulb in place for next season's growth. It is very desirable that this be done in order to prevent the plants from becoming too crowded. Instead of jerking the stem out of the bulb it may be cut off below the bulblets where the stem is bare. Deep planting—6 to 8 inches—is advisable for permanent plantings of this kind.

LENGTHENING THE FLOWER SEASON OUT OF DOORS.

Bulbs planted at the regular planting time, the 1st of November, will blossom in the climate of Washington, D. C., in early July. If the bulbs are held over and planted as soon as the ground can be worked in the spring they will blossom a month later, and seedlings grown from sowings made the 1st of January will begin to open about the same time as spring-planted bulbs. These will continue to flower until frost.

To get blossoms out of doors earlier than from normal stocks is a little more difficult, but still entirely possible. Bulbs can be put into 4-inch pots and set away at a temperature of 40° F. early in the year. They can be kept in frames and brought to varying degrees of development by spring, when they can be knocked out of the pots and set in the open. It will make no difference except to slow up their growth if the temperature goes below the freezing point for short periods a few times after the plants are well rooted. Handled in this way they can be brought to flower at least a month earlier than normal November planted stocks, thus giving blossoming plants out of doors from May until frost.

REDUCING THE COST OF HEAT IN FORCING.

By a little maneuvering, and this is always necessary in getting a batch of lilies in blossom for any particular date, methods can be worked out for flowering lilies with much less cost for fuel than now obtains with imported stock.

Seedlings potted from the field in October, in various stages of development, can be put into groups according to size and held in frames until the first of the year if wanted for Easter. The most advanced of them will need no heat until a later date, and from that time they can be kept much cooler than is usual with freshly potted bulbs.

It is suggested that it may be entirely feasible to carry bulbs in ordinary storage so far into the summer that when planted out they can be repotted for winter flowering in the field after as much as a

foot of stem has formed. With cold storage for a month or two, of course, this procedure would be possible.

It is thought that methods of timing stocks can be worked out for the warmer sections of California so that the plants can be brought into flower at almost any season with no artificial heat.

These possibilities, coupled with the further one of holding the cut flowers for two or three months in cold storage, suggest many modifications in handling and in supplying cut flowers for the market.

RESISTANCE TO COLD.

A light frost will not injure the Easter lily even when in flower. Plants in full flower and full bud have been known to withstand a temperature of 28° F. at night with no permanent injury. A temperature of 26° F., however, killed all the flowers and buds except a few barely in view and amply protected by the surrounding leaves. On the Gulf coast a drop from growing weather to 20° F. is considered fatal to plants in vegetative condition.

The six years' experience of the Bureau of Plant Industry has proved that this crop when properly handled is safely hardy in the climate of Washington, D. C. Proper handling means simply that the plants are set late, so as to insure dormancy during the winter. There are no data which enable one to judge just what the limiting temperatures are, but it has been amply demonstrated over a period of six years that the strains of the Easter lily worked with are hardy in the climate of Washington, where the normal minimum is 10° F. and the temperature commonly goes to zero at some time during the winter.

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